# Development and performance studies of TORCH readout electronics using custom MCPs in a test-beam

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**on behalf of the TORCH Collaboration,**
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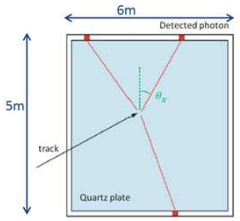
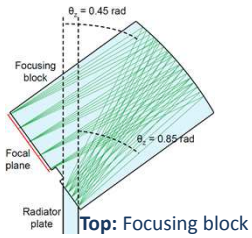
## Introduction

*TORCH— **T**ime **O**f internally **R**eflected **CH**erenkov light*




**Top:** TORCH Quartz Plate

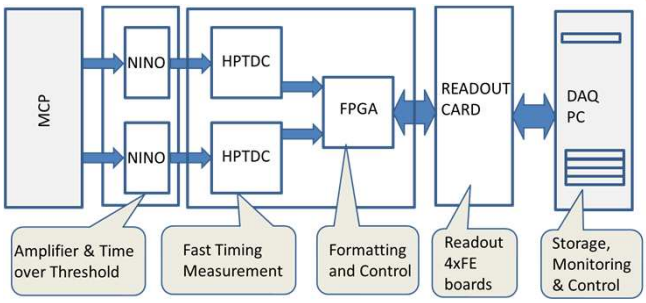



**Top:** Focusing block

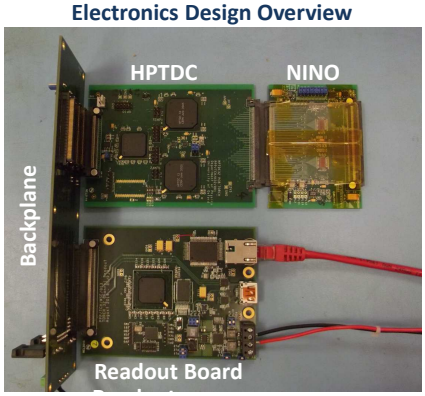
- TORCH is a high-precision time-of-flight detector suitable for large areas.
- The aim is to achieve a timing resolution of 15ps per incident particle, requiring a resolution of 70ps for single photons.
- Cherenkov photons propagate by total internal reflection.
- Photons are focused onto an array of Micro-Channel Plate (MCP) photon detectors at the periphery of the detector.
- Time-of-flight is measured by custom electronics.
- Working with industrial partner (Photek) to develop customised MCPs.
- TORCH will allow particle identification in the momentum region up to 10 GeV/c.

## Electronics Development

### Data Flow

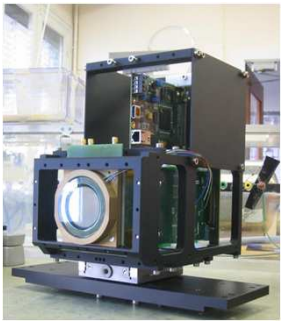



### Electronics Design Overview

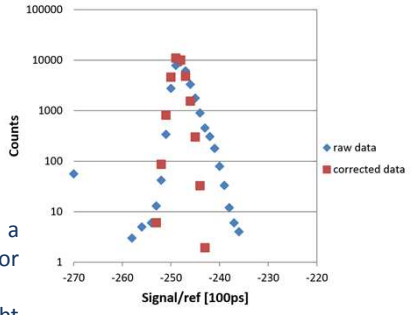



- Modular design uses separate PCBs for analogue Front-End, fast timing digitisation and readout to give flexibility in different stages of the development
- Provides up to 256 channels per system
- NINO board contains two 32-channel NINO ASICs with Time-Over-Threshold measurement for time walk corrections
- HPTDC board contains two 32-channel HPTDC ASICs for fast timing digitisation
- Readout board contains a custom Giga-bit Ethernet-based readout and slow-control system
- The readout system is interfaced with AIDA Trigger Logic Unit in order to integrate with VELO Timepix Telescope
- Built-in test trigger generator and edge-detection functions to suit different trigger sources
- Labview-based DAQ software offers control and set-up functions as well as basic data quality monitoring

## Coupling to Micro-Channel Plate

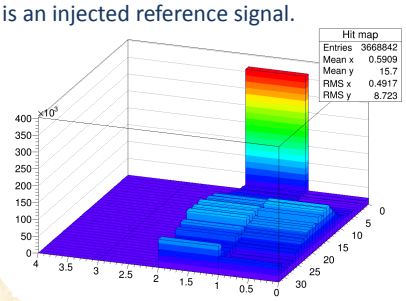


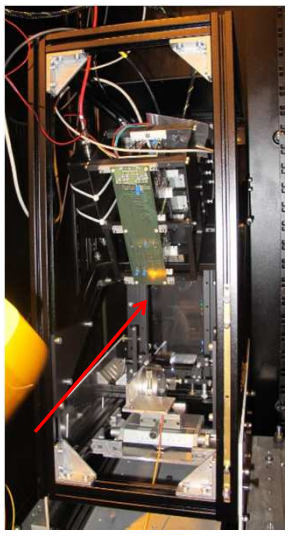
**Left**: Electronics coupled to a 32x4-channel custom MCP from Photek Ltd.
**Bottom**: An 85ps timing resolution has been achieved with a pulsed laser implementing INL and TOT corrections.




## Test-beam

The above system is coupled to a quartz plate and focusing block for Cherenkov light generation.
**Right**: Inside the TORCH light-tight vessel in the beam area at the SPS, CERN, May 2015. The beam goes through the quartz plate as indicated by the red arrow; photons propagate to the focusing block and are detected by the MCP
**Bottom:** A hit-map recorded in the test-beam. The highest peak on CH0 is an injected reference signal.



## Future Work

- Analysis of May test-beam data on-going
- Prepare for further test-beams
- Prepare for instrumenting 64x8 channel square MCPs for the final stage of Photek development

*TORCH is funded by*
*European Research Council*

For further information please go to our website:
*http://torch.physics.ox.ac.uk*